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DEPOSITS OF RADIOACTIVE ORES IN CENTRAL ASIA AND PROBLEMS OF THEIR UTILIZATION

I. Ya. Bashilov

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Industrial deposits of radioactive minerals were first found, both by pre-Revolutionary Russia and by the Soviet Union, in Central Asia. These deposits served as the first material for experiments in the industrial and technological utilization of this type of mineral. These first deposits consisted of uranium-vanadium-copper ore and were discovered at the beginning of the present century in the foothills of the Alay Range, in the vicinity of the Tyuya-Muyun Pass, which is located 62 kilometers south of Fedchenko Station on the Central Asia Railroad System, within the territory of what is now the Kirgiz ASSR. Beginning in 1926, substantial evidences of radioactivity and uranium minerals were discovered in the territory of the Tadzhik SSR, in the vicinity of Taboshar-Say and Sarymsakly-Say, 40-50 kilometers north of the city of Khodzhent (Leninabad).

Evidences of high radioactivity were encountered also in certain underground waters associated with petroleum deposits, particularly those in Turkmenistan, which lead toward the Caspian petroleum basin. A number of other such sources are known, such as those in the vicinity of Lake Issyk-Kul', the Kanibadam region, etc.

More recently, discoveries of radioactive minerals have been made in several other points in Central Asia, including those in Tadzhikistan, where there have been discoveries of minerals of the thorium group -- monazites, which can be mined on an industrial scale.

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As a result of these findings, the line of distribution of radioactive minerals, beginning from the Tyuya-Muyun Mine, has been lengthened several hundred kilometers to the west up to the outcroppings in the Zeravshan Valley in the vicinity of Samarkand.

It is therefore an indisputable fact that Central Asia possesses large manifestations of high radioactivity and radium-bearing minerals located in various sections of its extensive territory and that, because of this, it is, in its radioactivity, an extremely interesting and possibly rare region in the USSR.

Several specific characteristics of the above-named manifestations of radium-bearing minerals, however, prevent any simple solution to the problem of the industrial utilization of these resources. All known methods of working radium-bearing materials run into a number of difficulties arising from both the nature of the deposit and from purely technological conditions, since we are dealing with a completely new type of raw material for which industrial practice has not yet found efficient and established methods of processing.

The Tyuya-Muyun deposit of uranium-vanadium-copper ores is a system of karst holes situated in a narrow limestone ridge extending latitudinally for 6-8 kilometers and intersected by the gorge of the Aravan River. The exact height of this ridge, which has been built up from limestones of the Devonian and Lower Carboniferous Period, is 1,200-1,500 meters. To the north and south, it is pressed down by carbonaceous, clayey, and siliceous shales of the Upper Silurian Period and partially of the Cambrian Period. Some of the carbonaceous shales contain a high quantity of uranium and vanadium and are combined with anthroconite, sandstone, and intrusions of rock. The karst holes are represented in the ore field of this deposit by numerous (nearly 40) outcroppings of lodes, primarily associated with the northern slope of this range. Prospecting of several of these lodes has uncovered the extremely varied forms of ancient karst, resulting in the so-called tubular lodes, which are sometimes vertical and sometimes winding, with separate, large, local recesses, in which occasionally are still preserved, together with more recent fill-ins, tremendous cavernlike holes.

Prospecting and exploitation work, proceeding along the courses of the ancient karst, were at first dry operations, excluding minor infiltrations of surface water through crevices, but at a depth of 172.5 meters a relatively large water influx was encountered. The possibility of finding at this level even large underground water basins was not excluded, since the advance workings, particularly the crosscut which was being driven at this time and was to connect the main shaft of the mine with the lower workings of the main lode, were flooded when the ground-water zone was entered.

In prospecting the above-mentioned outcroppings of the lodes, it was shown that all these outcroppings and the lodes themselves were far from being of uniform metal content. Despite the fact that the transverse cut of the ore lodes for the most part showed a somewhat uniform scheme of distribution of the ore-bearing material, uranium-vanadium minerals were not found in all of the lodes. As shown in Figure 2, in the cross section of the tubular lode, there is a transition from compact original limestone surrounding the ore body through stalactites and stalagmitic crusts to ore marble, impregnated with uranium-vanadium and copper minerals, with primary, according to the terminology of A. Ye. Fersman, uranium-vanadates, and further, through barites to terra rossa, with stalagmitic crusts of the most recently formed karst. The valuable component here, from an industrial point of view, is the ore marble. In some sections of the main lode, the ore marble is hollow, with the uranium minerals leached out, while in other lodes the marble is completely absent. On the strength of this, the difficult and expensive process of prospecting by cutting from above was done primarily only in the one, so-called main lode, the transverse cut of which corresponds exactly to the above-described structural scheme of the ore body. In addition, prospecting by drilling from above was also carried out on the so-called Academic Lode, situated beside the main lode. Several geologists have recently proposed that the "Academic" is a simple offshoot of the main lode, cut off from it by a large fault.

During the prospecting, which in this case coincided with the exploitation of the deposit, two sectors of the mine were found to have great uranium-vanadium mineralization. Evidences of ancient Chinese copper-ore mining were found in parts of the main lode near the surface. The mineralization of the rock is so great that it was clearly evident even to the ancient industrialists.

Prospecting was begun in other lodes, but was abandoned when the cuts failed to uncover mineral deposits. One of these cuts came upon a lode descending almost vertically, while another of the cuts proceeded entirely along the tubular lode near the surface. Some minerals were found in the latter cut, but uranium and vanadium minerals were markedly absent. The former cut has only a negligible quantity of uranium minerals. These prospecting cuts were recently reopened, but still without outstanding results.

There is considerable interest now in the workings of the barite cavern, situated in the limestone ridge, and also in the above-mentioned lodes, but at a distance of several hundred meters from the main lode. This cavern is a large recess, the walls of which are lined with a barite layer under the limestone crust. According to Engr S. N. Ivanovskiy, former head of the mine, the prospecting, which was done at the lower part of the cavern and proceeded deep into the barite mineralization, revealed evidences of uranium and vanadium mineralization. This work also was abandoned and the question of the extent of the mineralization of the main ore field and the barite cavern remains unexplained to this day.

Among the numerous mineral compounds of the ore body in the Tyuya-Muyun deposit, the following minerals are of industrial importance:

Tyuya-munite ($CaO \cdot V_2O_5 \cdot 2UO_3 \cdot 4H_2O$) -- clear yellow in color; in some cases it has a clearly defined crystalline structure. In addition, this mineral is known to undergo colloidal change to a brown or various shades of green. It is associated in the deposit with the above-mentioned ore marble, highly impregnating the marble in different sections. Tyuya-munite appears to be the main mineral in the deposit.

Turanite ($V_2O_5 \cdot 5CuO \cdot 2H_2O$) -- olive-green vanadate, occurring in the form of crystalline radial crusts in hollows or forming solid serrated masses. It is found primarily in the upper levels of the mine. In the lower levels it is replaced by tangeite ($V_2O_5 \cdot 2CuO \cdot 2CaO \cdot H_2O$), a green mineral but of another composition. It appears to have a second variant which is green or almost black, occurring in solid colloidal formations and called Turkestan volborthite.

Alaite, which is extremely rare in the mine and is a free vanadium acid ($V_2O_5 \cdot H_2O$), and vanadinite ($3V_2O_5 \cdot 9PbO \cdot PbCl_2$), are among the vanadium minerals in the mine.

Radium in this deposit is mainly found in equilibrium with uranium. Although some specimens were not in equilibrium, there were found, on the other hand, specimens of the so-called radio-barites, in which the radium salts are present separately from uranium. Radioactive elements of the thorium group either are completely absent in the deposit, or are found in negligible traces. The latter condition is of essential importance in relation to the purity of radium preparations obtained in the chemical processing of Tyuya-Muyun ore. In addition to uranium, vanadium, copper, and radium, the presence of nickel has been determined in the ore, though in extremely negligible and industrially unimportant amounts.

According to the hypothesis developed by A. Ye. Fersman on the basis of a number of observations of the deposit, the structure of the ore body in the totality of its lodes is a system of karst holes which converge at some point on the present ground-water level. The system has a somewhat horizontal course directed toward the gorge of the Aravan River, as a certain natural level of erosion; the course terminates in the same material as is found in the upper part of the lodes.

The system of old karst holes, according to this hypothesis, was the result of the action of phreatic hot waters percolating through carbonaceous siliceous shales, extracting uranium and vanadium from the shales, and copper, nickel, and barium from the porphyrites which cut across the shales. These rising waters filled in the karst-hole system and deposited in it, in a certain sequence, the salts which were dissolved in them. As a result, the complex ore body observed in Tyuya-Muyun was formed. Fersman assumes that this last process had two phases. In the first, there occurred a fixation of uranium and vanadium from sulfate solutions, while in the second, barite was precipitated and a regrouping of copper and uranium occurred. With the passage of time, the action of the hot waters abated and was once more supplanted by the old karstic processes, which, with the gradual settling of the level of erosion, led to new karstic formations, the depositing of clayey and carbonate accumulations, and to the covering over of the ore formations of the preceding period.

The action of the hot waters led also to the formation of deposits which completed the development of the different parts of the complex system of the ancient karst, giving that variegation and irregularity in mineralization which is observed in the Tyuya-Muyun field with its numerous evidences of great karstic processes.

Following this hypothesis, it is absolutely necessary to descend by underground workings along the main lode to the above-mentioned horizontal course and to begin working upward from below in exploiting those funnel-shaped ends of the lodes which, according to this hypothesis, can be found at the juncture of the lodes with the main horizontal or slightly sloping underground course.

Fersman's hypothesis and his method of prospecting the Tyuya-Muyun deposit, the morphology of whose ore body as a whole, and therefore the known reserves of mineral resources, are actually known only several meters beyond the advance face of the underground workings, were singularly attractive to industrialists. On the one hand, in the process of direct mining operations, it allowed industrialists to test the accuracy of this same hypothesis, and at the same time to obtain a certain quantity of minerals for industrial processing into salts of uranium, vanadium, radium, and copper. It also opened before him a good prospect for the future, since the ore reserves in the lower levels can be expected to be great. At the same time, in operating according to the above-mentioned scheme, the entrepreneur was freed from the expensive process of prospecting the deposit from above, from the heads of the lodes which crop out on the ground surface and of which all, except the main and "Academic" lodes, have not lived up to expectations for the side recovery of ores during prospecting. Because of the extraordinary irregularity in the direction of the lodes' courses and the variegation in the mineralization and material composition of the lodes,

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prospecting operations by drilling from above also were not considered effective in determining the ore hidden in the depths of the limestone ridge.

However, the effects of the operations undertaken to force the cut downward along the main lode have led industry to its present discouraging position. The anticipated horizontal courses have proved to be, if they exist at all, considerably below the ground-water level. The ore mined below the water level after the first pumping did not bear any noticeable traces of leaching, and the water from the advance faces proved to be only slightly active in its mineralization and radium content. This indicates the distant stratification of the large deposits of radium-bearing masses.

It would be difficult at present to proceed further in this direction, since the drainage system organized in the mine with a capacity of 60 cubic meters of water per hour does not provide complete drainage. At the same time, installation of a large drainage system from a depth of 180 meters under the conditions of Tyuya-Muyun, which is situated far from any industrial center and 60 kilometers from railroad service, would necessitate considerable capital investment for construction of the right type of power plant. There still remains the problem of whether this capital investment would be justified, since the actual future extent of the mine, which can be supposed to lie some meters below the present advance face, is still completely undetermined. The mine thus appears to be at an impasse and operations have been stopped.

From recent drilling in the lower levels of the mine it was found that the lode continued 25 meters below the water level; valuable components of the lode were also uncovered. The reserves of ore material uncovered by these drilling operations, however, because of the complex structure of the lode, can only be of insignificant proportions, and therefore do not provide the needed stimulus for substantial investment in large-scale drainage equipment for the mine.

The possibility of finding a cheaper and more effective method of lowering the ground-water level is being discussed. It has been proposed to drain and lower the level of the outlets of two hot springs -- the Kok-Bulak, whose connection with the water flooding the mine workings has been established, and the spring which is nearly 2 kilometers from the main working and empties into the Tanga gorge, but has a very small flow. Another proposal involves driving a tunnel to the ground-water level through which the water could be drained out, carrying it off, by means of drainage slumps, in the network of underground channels of the Kok-Bulak. This measure would lower the height of the water rise and increase, to a large extent, the effectiveness of the present drainage facilities in the mine. Such operations themselves, however require a certain expense and an extremely careful analysis of the hydrology of the mine and its waters.

The technological and industrial phase of the matter can be considered solved. A plant under the supervision of "Soyuzredmet" (All-Union Office for Prospecting Rare Metal Ores) in Moscow is processing the ore of this deposit. In addition, despite other discoveries in recent years of radium-bearing resources in the USSR, Tyuya-Muyun remains the only definitely established deposit which can satisfy the USSR's needs for pure radium salts which have no admixture of mesothorium. Consequently, in an industrial sense, it remains the most noteworthy deposit.

The composition of the ore mass extracted directly from the advance faces can be characterized by the following figures:

Table 1

Composition	U_3O_8	V_2O_5	CuO	Fe_2O_3 + Al_2O_3	$BaSO_4$	SiO_2	$CaCO_3$	H_2O
Content (%)	0.2-1.0	0.3-1.5	1-2.0	1.5-8.0	Traces - 20.0	0.5-5.0	59-85	0.1-0.8

The chief mineral components of the ore material in the lower levels of the main lode are presented in the following approximate figures (in percent): ore marble 19.5, barite (red, white, and yellow) 45.0, clayey material 19.5, and crusts and altered material (leached ore marble, etc.) 16.0; total, 100 percent.

In other words, the composition of the ore material varies considerably in the percent of its main components, while it is sufficiently poor in valuable ingredients.

Preliminary concentration of the material is necessary for processing the ore. This has been done in the mine by hand, by separating out the lumps of the ore marble most mineralized by uranium-vanadium and copper salts. The scheme for this selection consists of hand-screening of the entire ore mass brought to the surface, while the large lumps, in the following three categories, are separated out: (1) waste rock, including lumps of crust, limestone, clayey material, and those lumps of ore marble which have been completely leached and which on the exterior do not appear to include any minerals; (2) barite, in which group are put lumps of red, white, and yellow barite; and (3) concentrate, in which are included lumps of ore marble with mineral components. This selection process is completed by using hand hammers to split remains of waste and barite rock from the ore marble.

In addition to the three groups, the selection results in a considerable quantity of finer rock mixed with fine powdered material. These fines are thrown on a screening table which has holes of approximately one centimeter. The fines remaining on the table are passed through the same selective process as described above. The fines are collected and stored in a general dump and remain unused at present. The composition of this material is as follows:

Table 2

Composition	CuO	U_3O_8	V_2O_5	$BaSO_4$	$CaCO_3$	SiO_2	ΣMe_2O_3
Content (%)	1.64	0.62	2.52	31.8	52.25	3.04	6.55

The method of obtaining this material makes it unsuitable for reprocessing since it has an extremely high content of barite, which prevents it from being worked for radium. It needs treatment by machine concentration, for which there is not yet complete data. There is only an indication, derived from tests made in the laboratories of "Mekhanobr" (Scientific Research Institute for Machine Processing of Mineral Resources) and "Morgintsvetmet" [Moscow Division, State Scientific Research Institute of Nonferrous Metals?] of the possibility of removing barite by flotation. But this work has not gone beyond the laboratory stage and a considerable amount of the material lies in the mine dumps. This is the only factor in the technology of Tyuya-Muyun radium ores which has not been worked out.

It should be noted that the work on machine concentration of Tyuya-Muyun ore has been done by several methods, most important of which was based on fine crushing of the material by using a Wilfley table. Although this procedure had some results, they were not such that they could be adapted for industrial exploitation. For example, this method yielded poor concentrates with a low recovery of uranoso oxide-uranic oxide in the concentrate (of the order of 40 percent). The radioactive substance was thus dispersed among all the fractions obtained by this process.

Flotation of the material has had somewhat better results. Using soluble glass and oleic acid as the main reagents, it is possible to float barite and calcite, leaving the valuable components of the ore mass in the residue. Thus, from experiments conducted by "Mekhanobr," it was possible to obtain a barite concentrate with a negligible amount of uranium oxides, leaving the latter in the residue. The recovery of uranium in this case in the proper fraction was increased to 71.4 percent, while the content of barite remaining in the uranium was less than 5 percent. In this way, the use of flotation in processing the fines obtained as a result of hand-sorting of the ore mass makes it possible to recover a considerable part of their valuable consituents in a form which is completely adaptable for further chemical processing.

As has been pointed out, chemical processing has been done only on that part of the entire ore mass which has been selected in the form of a concentrate of ore marble and from which the "Soyuzredmet" Plant in Moscow is obtaining both radium salts and salts of uranium, vanadium, and copper.

Such, in general outline, is the situation in the Tyuya-Muyun Mine, which at present can be termed somewhat critical in the sense that, despite a number of favorable conditions, the economist is faced here with the necessity of expending considerable sums for drainage, while at the same time he has no real assurance of the effectiveness of this measure, since the genesis and morphology of the deposit is still far from being explored.

The situation in the Taboshar deposit is also a difficult one, but for quite another reason. This deposit was discovered in 1926 when uranium minerals were found here together with discoveries of nonferrous metals. The minerals were discovered in negligible amounts over a large area. They were first found in the ancient workings of Taboshar-Say, but later, larger manifestations of radium-bearing ores were found in the adjoining section, at a distance of 2-3 kilometers, in the vicinity of the Sarymsakly Say and near the village of this same name. The mineralization here is represented mainly by otenite $(Ca(UO_2)_2 P_2O_8 \cdot 8H_2O)$, torbernite $(Cu(UO_2)_2 P_2O_8 \cdot 8H_2O)$, and zeunerite $(Cu(UO_2)_2 As_2O_8 \cdot 8H_2O)$. It is coincident with quartz-barite lodes which cut through a series of granodiorites, primarily in a latitudinal direction. The granodiorites in places are greatly modified, with evidences of alunitization, sericitization, and kaolinization. Several lodes have been determined in the deposit, including the Northern, Leading, Uranium, and a whole series of offshoots connected with them. The boundaries of the mineralization are two large tectonic fissures running apart for 10 kilometers and converging at an angle on the northeast, near the mouth of the Chet-Su River. In addition to uranium minerals, there have also been discoveries of tungsten, from which one of the southern lodes of the Sarymsakly section gets its name, Tungsten Lode; fluor spar, also found within the boundaries of one of the lodes; and, most recently, bismuth.

Although the deposit has been prospected since 1926, it is still difficult to determine conclusively the extent of its industrial reserves, because of its peculiarities. The mineralization here is not rich and occurs in extremely fine and irregular conglutination (primazka) of uranium minerals with the surrounding rock and in the crevices and small cavities distributed through it, while on the exterior, it seems to impregnate the rock over a rather large area in the direction of the above-mentioned quartz-barite lodes. The width of such zones of mineralization ranges from 2 to 12 meters and more, and there are as many zones as there are lodes.

Thus, taking into account the entire area, which is distinguished by its relatively high radioactivity as compared with the activity of usual rock, and taking into account even the shallow depth of its occurrence, with the content of uranoso oxide-uranic oxide in hundredths of a percent, then the total reserves of radium for this section are represented by a substantial figure, a fact which definitely makes this deposit worthy of consideration. It is possible that there are some sectors with a higher content of U_3O_8 [$UO_2 \cdot 2UO_3$] approaching those which can be considered of industrial importance in the usual technological sense, but if they do exist, they are still very few and far between. (The theory of the possibility of finding concentrated sections was confirmed in 1934 when parties of "Giredmet" found accumulations of ore with a content of U_3O_8 as high as 1.5 percent. These accumulations were discovered at the maximums of the emanation survey.) Moreover, they all occur, apparently, in accumulations which are very limited in size and are distributed extremely irregularly and without conforming to any evident principle throughout this entire tremendous area.

The appearance here of this type of more concentrated reserve is such that the only suitable method for surveying the deposit for this purpose is a new method such as radiometric survey, which, together with usual prospecting methods, has been carried out here for a number of years under the direction, and at the suggestion of, Mine Engineer A. P. Kirikov. This radiometric survey was done in two ways: (1) the content of the emanation was systematically determined by the absorption method in the soil of the ore field from its surface, and (2) the intensity of the penetrating radiation on this same surface was determined by using a Kol'gerster gamma-electroscope. This last survey was made directly on the surface of the ore field in a series of points after the removal of a fine layer of alluvium. Points with general indications of radioactivity, according to this or the other method, were connected, and thus was obtained a network of certain curves, "isorads" (izorad), which definitely point toward the quartz-barite lodes with separate points and fields of several maximums and minimums.

This radiometric map, however, has still not resulted in any definite conclusions as to the reserves of the deposit, and has indicated only separate, more interesting sections of certain centers of radioactive emanations. It actually has only helped to show the extremely large range of the occurrence of the weak, in the industrial sense, radioactivity of this region. In particular, there has still not been established any quantitative relationship between the evidences of the radiometric network and the actual distribution of radioactive substances in the rock. From this point of view, the work done here is extremely interesting in the study of radioactive phenomena in nature, but must be verified by experimentation with the aid of the usual methods of prospecting and research.

The two zones which have been determined in this deposit are the surface zone, that is, the zone of oxidized ores, and the underground zone which lies somewhere below the level of the ground waters, which occur here at a depth of approximately 35 meters from the surface. In the surface zone, there are a number of relatively shallow prospecting pits and shafts, sunk in one case to a depth of 5 meters below the ground waters, and a number of tunnels and drifts on various levels underground. Facts gathered from testing the walls and individual sections of the underground workings by grooving and studies made of them for penetrating radiation also indicate the general scarcity of radioactive materials in the rock and their uniform distribution. Recently, according to A. [illegible] Kirikov, there was established the growth of activity in the specimens obtained in one of the horizontal underground workings leading from a shaft in the Leading Lode toward a maximum of radioactivity as determined by the emanation survey. The order of the activity and the nature of its distribution, both on the surface and in the underground workings, is given in the following table, where the activity is given in certain specific quantities according to a certain standard unit:

Table 3. Distribution of Activity According to γ-radiation of the Surface in the Vicinity of the Leading Lode

Distance From Lode Center (in m)	North -9	-6	-4	-2	0	+2	+4	South +6	+8
Activity in vicinity of 8th pit	0.068	0.073	0.078	0.065	0.137	0.162	0.070	0.051	0.034
Activity at distance of 20 m to west from 8th pit	0.027	0.035	0.031	0.032	0.032	0.040	0.032	0.020	0.022

Table 4. Distribution of Activity According to γ-radiation in the Shaft and Crosscut at Depth of 20 Meters in the Pit of the Leading Lode

Shaft of Pit: Distance From Mouth of Shaft (in m)	Activity	Southern Crosscut: Distance From Shaft (in m)	Activity
2	0.048	0.5	0.030
5	0.083	1.0	0.022
7.3	0.146	1.5	0.023
10.0	0.100	2.0	0.026
13.2	0.121	2.5	0.028
16.0	0.083	3.0	0.022
17.5	0.070	3.5	0.025

In several sections of the deposit, the yellow variety of uranium mineralization predominates, and in others, the green. From observations made during prospecting, it was established that uranium in the minerals of the surface zone is not found in radioactive equilibrium with radium, and the ratio of the uranium to radium ranges from 15 to 95.4 percent of this equilibrium. On the other hand, specimens were found in which an excess of radium occurred, and, in analyzing the specimens of minerals together with the surrounding rock, the excess of radium was found at times to be very great. Therefore, it can be said for the average specimens of ore material that radium and uranium are found there in equilibrium.

Zinc, lead, tin, arsenic, and bismuth are also present in the deposit, in addition to uranium minerals.

The analysis made in the "Giredmet" (Central Scientific Research Institute of Rare Elements) laboratory of material selected by hand from the deposit and rich on the exterior resulted in the figures presented in Table 5. In selecting specimens for analysis, the specimens in 20-kilogram lots were collected in two groups -- the so-called yellow ore and white ore. The first is characterized by the yellowish brown color of the surrounding rock, with a predominance of yellow uranium minerals, and the second is a white alunitized rock with green varieties of uranium minerals (torbernite and zeunerite). The third analysis in this table presents the "average" specimen of the concentrate selected from the mine by hand, primarily from 2,500 tons of ore mass obtained in the Leading Lode.

Table 5

Content (in %)	CaO	BaO	SO_3	Mn	P_2O_5	CuO	PbO	Na	U_3O_8	Bi	Losses in Calcination
Yellow ore	1.12	none	1.08	0.80	0.32	0.033	0.047	0.06	0.03	0.0055	4.32
White ore	0.42	0.70	2.10	trace	0.21	0.069	0.25	0.06	0.39	0.0007	2.74
"Average" specimen	0.16	0.12	3.13	indef	indef	0.06	0.28	indef	0.38	0.0006	3.92

Thus, the Taboshar deposit of uranium minerals is, according to our present notion, a unique deposit, though poor in radium-bearing minerals, and at the same time, is a complex deposit in which other elements are found widely dispersed. For industrial utilization of these deposits, special technological methods are necessary to enable effective processing of at least part of the material into a commercial product. Tests made by the author in laboratories of "Giredmet" and in the laboratory of the technology of rare elements in the Moscow Institute of Fine Chemical Technology have shown there are certain potentialities in this direction.

Uranium minerals have proved unstable even in relation to salt solutions. Solutions of bicarbonates, and then of chlorides, for example, act as decomposing agents on these minerals, and a relatively short action of the same type of solution leads to a partial (actually slight) leaching of radioactive substance, while distilled water and water taken from the Moscow water system have no noticeable effect on the ore material. Diluted mineral acids, particularly salt and nitric acid, affect the material to an even greater extent. Salt and nitric acids, even taken in small quantities and with a concentration of 0.2-0.5 of the normal, lead to a complete leaching of the radioactive substance during the course of a short period of action on the ore which has been crushed to 2 millimeters. By using very simple and inexpensive equipment, it has been found completely possible to separate radium from the ore mass in solution and, consequently, to make use of the ore material even with a low content of uranoso oxide-uranic oxide. According to our experiments, the minimum content of U_3O_8 is 0.25-0.30 percent when the uranium is in equilibrium with the radium in the ore mass.

from similar solutions, by using certain special methods, it has also been found possible to obtain a radium-bearing barite concentrate equal in radium content to the corresponding concentrate obtained by processing Tyuya-Muyun ore.

If the possibility of removing from the surface zone ore material with the given content of uranoso oxide-uranic oxide (and in considerable quantities) is established, then it will be possible to consider arranging at the mine for processing the ore material into salts of radium and its associated minerals. Several complications are attendant on this proposition. The author's experiments have shown that the percent of recovery of radioactive substance, even with the action of mineral acids, lessens to the degree that the barite content of the ore is increased. The introduction into the ore mass of barite, taken from the quartz-barite lodes of the deposit in quantities up to 2 percent of the ore weight, sharply decreases the yield of radium, other conditions being equal. Subsequently, in selecting rich sections of the deposit for the purpose of chemically processing the ore, it is necessary to avoid the inclusion of barite. This will not be easy since the quartz-barite lodes present in places a considerable number of apophyses and fine veins of barite in the main mass of the mineralized material. (Later, the author's experiments showed that it is possible to overcome the harmful effect of the barite. It was proved that an extremely good recovery of radium can be obtained with the action of weak acids, even when the barite content in them is more than 2 percent, by making slight additions to the technological scheme, described further on, for the ores of this deposit.)

In addition to chemical processing of Taboshar ore, methods of machine concentration have been studied, though also on a limited scale. The sharp contrast in physical and mechanical properties between the surrounding rock and the valuable minerals has led us to expect some success in machine concentration, and tests made with this in view have upheld this opinion. The laboratories of "Mekhanobr" were successful in obtaining a considerable concentration of the content of U_3O_8 in the concentrate with a sufficiently satisfactory recovery of the valuable component by flotation. These results were confirmed by work done for the same purpose in the "Giredmet" laboratories. Further, it was established that uranium micas are very easily crushed as compared with the surrounding rock. In many cases, green micas are located in small crevices in the rock in the form of compact foliate accumulations, sometimes showing traces of sliding. In mining the ore material and in crushing it, these small leaves of mica break off from the rock and are easily crushed into a fine powder. In crushing, there occurs a noticeable concentration of the fines with valuable components, and on this basis, it is possible to construct a scheme for mechanical concentration of the ore material.

Flotation of the crushed ore mass results in the yield of uranium concentrate in which barite is present. Separation of the latter, although not complete, can be done by buddling in light of the great difference in weight between barite and mica. The barite, being heavier, remains massed in the heavy unbuddled portion.

The following scheme for processing the Taboshar ore mass has been drawn up in expanded laboratory experiments. The radium-bearing barite obtained as a result of this process will be reduced to radium salts in the Center /Moscow?/ and the solution containing uranium and copper can be neutralized to a very weak alkaline reaction by slaked lime, which will result in a certain concentrate with the following composition (per dry weighted portion):

Table 6

Composition	U_3O_8	CuO	SiO_2	CaO	SO_3
Content (%)	14.85	2.35	6.10	14.99	10.07

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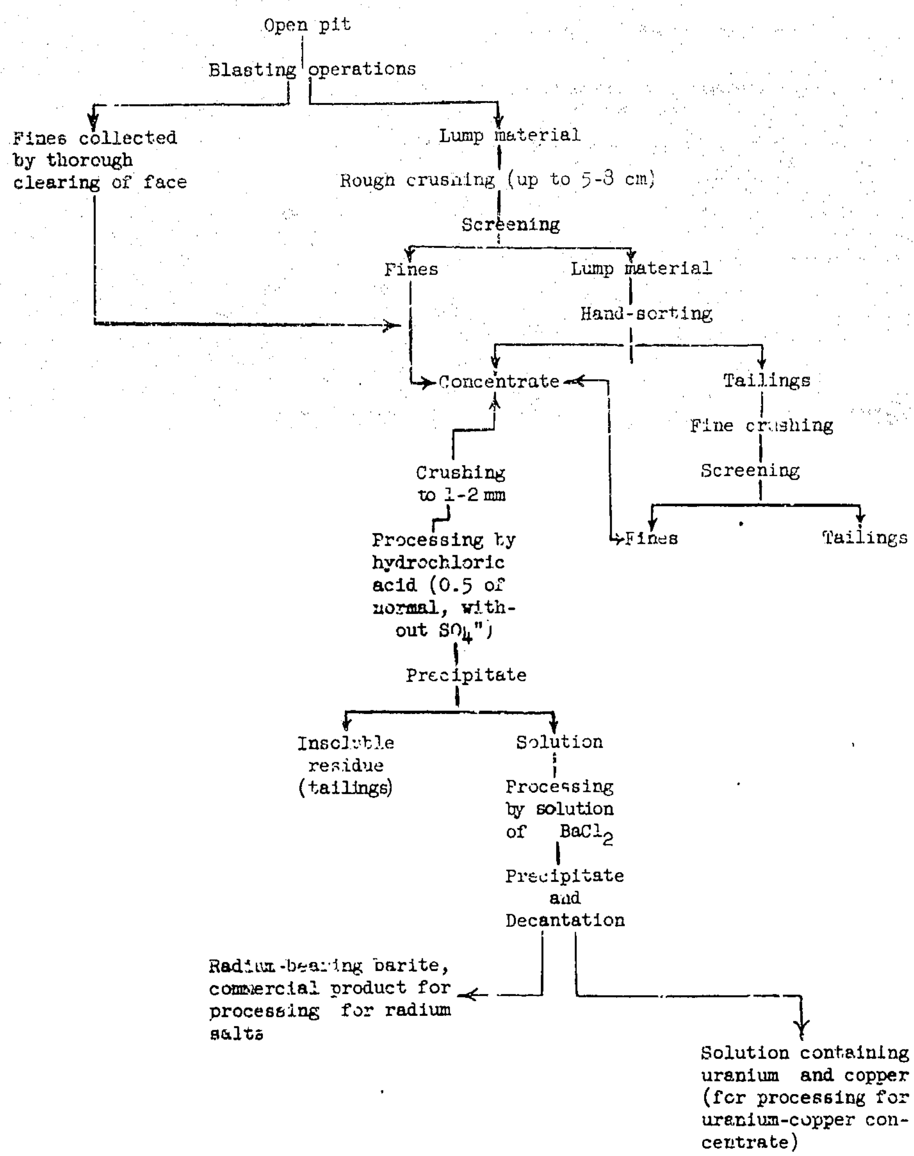
This concentrate has a known value and can be reworked easily into uranium and copper salts.

The following scheme is simple both in operation and equipment. All chemical operations can be done in wooden drains.

Scheme for Working Taboshar Ore



Radium-bearing waters, in association with petroleum deposits, are the third occurrence of radium-bearing minerals in Central Asia which have industrial significance. Research of the past 5-6 years in the USSR has shown that the water associated with petroleum deposits is radium-bearing, that is, it contains, together with other mineral components, radium salts and mesothorium. This water's radium and mesothorium content is definitely not great and varies for different regions and for different oil wells in one region in a rather wide range from 10^{-11} to 10^{-9} percent. The Turkmenistan petroleum regions of Cheleken Island, Nefte-Dag, and Boya-Dag have also proved to be radium-bearing. These waters are a completely new type of raw material in radium elements. Table 7 shows the composition of these waters and comparative analyses of other deposits, both USSR and foreign. Only the chief components are given:

[Table 7 follows.]

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Table 7

Composition	Cl'	Br'	J'	SO_4''	Na·	K·	Ca··	Sr··	Ba··	Total soluble properties (in %)	Author
Cheleken Island											
Mirzabek Well (in mg/cu cm)	2395.6	Not determined	0.8	10.1	1170.0	87.9	237.8	7.6	--	--	N. V. Tageyeva
Old Field area	Not determined				Not determined			Not determined			State Radium Institute
Karakyn	"	"			"	"		"	"		
Well No 200	"	"			"	"		"	"		
Ukhta Kazen No 1 (in g/liter)	26.6280	Not determined	--	None	12.8760	0.1712	2.7197	--	0.0390	49.990	A. A. Cherepennikov
Heidelberg (in g/kg)	--	--	--	--	52.0 (NaCl)	7.525 (KCl)	19.08 ($CaCl_2$)	0.5613 ($SrHCO_3$)	0.02485 [$Ba(HCO_3)_2$]	--	Bekker

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Taking into account the fact that the daily flow of water now amounts to several thousand cubic meters and that it will increase in the near future in connection with the prospecting and the expansion of the production of iodine and bromine from these same waters, it is possible to assert that the supplies of radium and mesothorium concealed in these waters are of definite industrial interest. The total quantity of radium mined throughout the world since its discovery is little more than 800 grams. Taking into account that part of it has been irreparably lost through practical utilization, it can be assumed that mankind now has no more than 500 grams. The radioactive elements lying unused at present in petroleum-bearing waters represent a sufficiently large proportion of the given world fund.

The work done by the author in the State Scientific Research Institute of Rare Elements in relation to the Cheleken waters indicates that the task of recovering radium in processing the water for iodine and bromine is not particularly complex.

From an industrial and technological point of view, all radium-bearing waters can be divided into three categories, sharply differentiated according to the possible methods of working them for radioactive salts. The first class includes the radium-bearing waters which do not contain barite salts; the second class includes the waters which contain barite salts, but in such quantity that, in complete or almost complete precipitation of barium from this water as a sulfate, a barite precipitate is obtained in which is concentrated all or nearly all of the radium and its isotope, mesothorium, in a quantity of 50-70 kilograms per ton of barite, according to the γ-equivalent; the third class includes that group of waters which contain a high quantity of barium. On the strength of this, the radium-bearing concentrate precipitated from this water as a barium sulfate proves to be extremely poor in its relative content of radioactive substance.

At present, on the basis of the author's work (see "Author's Testimony," I. Ya. Bashilov, No 24394, in Statement of 7/9/29), the second class of waters has been the most thoroughly studied from a technological and industrial point of view. The problem of recovering radium from these waters is solved most simply by utilizing the reaction of weakly-soluble sulfates, particularly calcium sulfate, and of the inexpensive and accessible compound, gypsum, on the water. The addition of gypsum or gypsum water, that is, the solution of CaSO made separately in water, to the radium-bearing water precipitates all the barium as a sulfate and together with it all or nearly all of the radium and mesothorium. After the precipitation of the barite from the water, which can be achieved easily in the case of slowly running water, a radium-bearing barium sulfate is obtained which can be reprocessed by usual and well-known methods to pure salts of radium and mesothorium. A high mineralization of the water very often hastens this process, increasing somewhat the solubility of gypsum. The industrial application of this process is not difficult since the entire installation can be arranged either in a series of settling tanks, or as a system of drains with step-wise drops and settling tanks placed in the path of the radium-bearing stream. These drains or several of the settling tanks can be used also for adding gypsum to the water. Since gypsum is cheap, and the installations for obtaining radium-barium concentrate, which can also be called installations for purifying the water of barium and radium salts, are not complex, this method can be used to process water which contains a very small quantity of these salts.

The problem of the first class of waters is somewhat more difficult to solve. It is possible to use the method of introducing a minimum quantity of barium salt to the water, resulting in the condition just described and utilizing it as was shown above. In the first place, however, this is an unnecessary operation and in the second place, the possibility of it is complicated by the fact that certain waters of this type, as the author's experience has shown, contain soluble

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sulfates, and the introduction of barium in minimum quantities and uniformly in relation to the entire mass of water being processed is not an easy task. Therefore, in this case it is perhaps preferable to use the method in which the water is allowed to filter through a layer of barite. This method, according to experiments with certain waters of this type, has proved to be sufficient to recover radium in quantity from the water. This method has not been tested in large installations and, most important, the limit of saturation of the barium sulfate with radium salt has not been determined. At the same time, it is known that such a limit exists; in particular, various types of barite act differently in absorbing radium salts from the solution and in the speed of this absorption. It is also possible to precipitate radium and mesothorium by filtering the water through a layer of celestine and lead sulfate.

The third class is the most difficult. Water containing considerable amounts of barium can be processed in the preceding way, but the radium-bearing concentrate obtained thereby is too poor, and the process of obtaining from it pure radium salt, even by those modern methods which have been developed by us for this purpose, although technically feasible, is extremely expensive. Therefore, the task of separating radium from this water is linked with the task of simultaneously separating the barium salt from it. This latter task, according to present data on the technology of radioactive substances, is achieved most simply by using a number of successive fractional crystallizations of the solution of radium-barium salt or by means of fractional precipitation. But, to perform these operations in relation to the large mass of liquid is impossible, the more so because it is a solution which is very weak in radium and barium salts. A rich field thus remains for studying new technological methods of separating radium and barium salts, and special research should be instituted.

What these methods are is made clear by the fact that radium salt can be separated from its solution not only by precipitating it together with barium salt, but also with other weakly soluble sulfates. Thus, from the author's experiments, radium is separated effectively from the solution together with the following salts, which are placed in the order of the effectiveness of the precipitation under the same conditions and with the same weight unit of each sulfate: lead sulfate, barium sulfate, strontium sulfate, and calcium sulfate. Subsequently, having barium and radium salt in solution and using an excess of lead or strontium salt, it can be expected that, in the formation of the total sulfate of these salts, part of the radium salt will combine with the barium sulfate and also with the sulfate of the added salt. Converting the latter to a soluble form and separating it in this process from barium salt, we thus also separate part of the radium salt. Consequently, having recombined the radium salt with the barium, but using a definite, in required quantity of the latter, it is possible to regenerate the auxiliary salt needed for the precipitation and to obtain a rich radium-barium concentrate. Such a possibility has been proved by the author, and he is now doing work to extend the study of this process with the goal of obtaining more effective practical results.

In working out the problem of industrial utilization of waters of the third class, it is necessary to bear in mind also the other possibility of separating radium and barium which consists of mining and prospecting methods. The radium-bearing property of well water is not necessarily associated with the presence in it of considerable amounts of barium. Therefore, it is completely possible that the abundance of barium salt in the stream of water flowing to the ground surface is added from other than the radium-bearing levels, and also that the water with barium mineralization can also be nonradium-bearing. It is thus completely possible to separate this water containing excess barium by mine operations, by the proper assembly of wells, etc. In order to do this, it is necessary to follow closely the change in mineralization of the water with the depth and to obtain a clear picture of the genesis of this same water and its radium-bearing properties and of the distribution of the underground streams in a given region.

The introduction of this type of hydrological study is particularly pertinent in new regions where drilling for petroleum is undertaken, particularly in the Transcaspian region, in the Central Asian Soviet republics. Because there are still few wells in this region, the underground regions are not the type of "sieve" as is found in the Baku area where many of the underground streams are already connected, having been joined to each other by wells, and where the natural network of underground waters has been radically altered by man's industrial activity.

Several observations made by the author have persuaded him that the lack of radium-bearing properties in some wells issuing water can be explained clearly by the fact that streams bearing soluble sulfates are joined to the main radium-bearing water somewhere below the ground. A precipitation of the barium sulfate, carrying with it radium, has occurred and the water has become nonradium bearing. This is probably the case in the Neftechala region of Azerbaydzhan where the water of several wells, processed to recover iodine, contains barium sulfate suspended in negligible quantities in it, and at the same time, has a high content of soluble sulfates. The author, in handling a precipitate of this barium sulfate from the water, has observed that it was slightly radioactive, although this same water had been classified as not containing radium.

It should be noted that the radium-bearing property of petroleum-well waters is a new phenomenon recently established by Soviet research and that it naturally is still little suited, and should therefore claim the attention of all workers who are connected in any way with the prospecting and exploitation of petroleum deposits. The waters of these deposits are frequently a very interesting and extensive source of radium salts, a source which can produce a sharp increase in the balance of world extraction of salts of radium and its isotopes.

Such are the large occurrences of radioactivity in Central Asia. In addition, to these, there are separate findings of radioactive minerals in a number of other places, so that, in comparison with other regions of the USSR, Central Asia is perhaps one of the most interesting and extensive regions in regard to the occurrence of radium-bearing minerals.

In addition to the Tyuya-Muyun and Taboshar deposits, the presence of uranium minerals, although widely dispersed, has been established in Kara-Chagyr (southern Fergana), where kolovratites were found in the form of slight efflorescences, and in the vicinity of Samarkand, near the village of Agalyk. The Agalyk deposit was discovered in 1933 by a group headed by Prof V. A. Zil'berminets from the Tadzhik-Pamir Expedition. Yellow and yellow-green conglutinations and efflorescences, in which were determined the presence of uranium and vanadium, were found here in the shale, in association with bituminous rocks. It is proposed that these mineral formations are tyuya-munite. In addition, radioactive minerals were discovered at a number of points in regions to the west of Tyuya-Muyun.

At present, neither the Kara-Chagyr nor the Agalyk deposits are of any interest from the point of view of exploitation, since from present information it is impossible to determine a single point in which there might be substantial accumulations of uranium-vanadium minerals. Both are interesting, however, from a theoretical point of view, and, in particular, in the study of the principles of the migration of radioactive elements in the earth's crust.

The Agalyk deposit, located at the beginning of the Zeravshan Valley, is also interesting because of the fact that it was, in a way, predicted by D. N. Nalivkin. Judging from geological data and the presence of graptolite shales in the Zeravshan Valley, Nalivkin definitely indicated the possibility of finding in this region radium deposits of the Tyuya-Muyun type ("Geological Structure of Tadzhikistan; Problems of Tadzhikistan," D. V. Nalivkin, in Works of First Conference on the Study of Productive Forces of Tadzhik SSR), basing his conclusion on the genetic connection, established by A. Ye. Fersman, of several carbonaceous shales of Tyuya-Muyun with the same deposit.

A large, latitudinally extending zone of radioactive manifestations along the southern part of the Fergana Valley, beginning from Tyuya-Muyun through the environs of the village of Rustil' and Isfara to Kara-Tau, has been denoted by the discovery of radioactive minerals in Agalyk.

The prospecting of the Agalyk deposit in 1934 discovered a considerably higher impregnation of the shales with uranium and vanadium minerals concentrated in a large section. The 1934 specimens pose the question of the industrial utilization of the uranium and vanadium conglutination and deposits in the shales, all the more because their weak acids are easily soluble. Because of this, the possibility of using the methods developed for Taboshar in the Agalyk deposits has not been excluded.

In addition, the 1934 prospecting revealed extensive uranium-vanadium mineralization in the Fergana limestone pits along the Mayli-Su River, 50 kilometers to the north from Andizhan near the village of Charvan. The average content of U_3O_8 in this deposit is determined to be of the order of 1-3 percent. The mineralization is uniform and has been detected over a considerable area. This region is characterized moreover by the petroleum-bearing and radium-bearing properties of the well water. The known extent of radium-bearing minerals in the Fergana Valley has been expanded exceedingly by these recent discoveries.

Thorium in Central Asia occurs in a number of placer deposits, of which the most interesting are those found by the Tadzhik-Pamir Complex Expedition in 1932 at the mouth of the Bash-Gumbez River in the Alichur Valley, East Pamir. These deposits, found at a height of 3,800 meters, are situated on the Khorog-Osh automobile road, 450 kilometers from Osh, in a rather extensive area covered with moraines which are hidden by sandy and fine-gravel river deposits. The presence of monazite and zircon was determined in one of the sections of these deposits by surface tests and shallow (up to 2 meters) prospecting pits. Panning yielded from 100 to 1,300 grams of monazite and zircon per ton of rock. But it is proposed that these figures, because of the extensive washing away which occurred in panning, underestimate the ratio. The ratio of monazite to zircon is estimated at 3:2. According to S. N. Klunnikov and V. Stratonovich, in the prospected area of 3 square meters alone, the deposit contains as much as 15,000 tons of monazite and 9,000 tons of zircon. Deposits containing the same minerals have been found higher, along the Bash-Gumbez and the stream which flows into it.

The intrusions of porphyritic granite, extending in a latitudinal belt, are in this case original deposits of monazite. According to D. I. Shcherbakov, the Pamir placer deposits coincide with a gneissic stratum, which has seams of marble, injected with variscite grainite and pegmatites, and which occupies an area of several thousand square meters in the southwestern Pamir region.

If the average content of monazite in the rock is taken to be 250 grams per ton, then the monazite content is 0.025 percent. This is a very low figure as compared with the Brazilian and Indian deposits of placer monazite, for which a content of 6 and 8 percent does not represent the highest figure. It is a higher content, however, than in the monazite deposits of the Borshchovochnyy Kryazh and much higher than in the Ural deposits along the Samarka and Kamenka rivers, where the monazite content does not exceed hundredths of a percent, even in the richest sectors. The presence of zircon, which can be mined on the side, is a favorable characteristic of the Pamir deposits. The presence of water, which has impregnated the deposit to a slight extent, is a condition which will facilitate the installation of a concentration station on the spot, but will also tend to complicate mining operations.

The Pamir monazite deposits are unique in the Soviet Union and demand serious attention and study. The same is true of the zircon which gives the deposits their preeminence and the basis for their rapid industrial utilization. This last should be directed toward finding the most effective and the simplest method of obtaining both monazite and zircon concentrates, which should be obtained on the spot.

In regard to the chemical processing of concentrates, we already have the result of years of work done in the State Scientific Research Institute of Rare Elements in Moscow and other USSR institutions, which have been quite active in recent years in studying the monazite concentrates of the Urals and some imported concentrates and in studying other rare materials, in connection with Soviet industry's needs for rare earths.

In addition to Pamir deposits, discoveries of monazite in Central Asia have also been noted (A. V. Sosedko) in the Kara-Kalpak Kyzyl-Kumy, where the presence of monazite in the slime in association with cassiterite and tantalite has been determined. Analagous discoveries were made by the same A. V. Sosedko in the Kara-Tyube Mountains, where the same minerals have been found in slime not far from Samarkand. Somewhat earlier, the occurrence of monazite was determined also in the slimes of the Kok-Su, Alayskaya, and Chatkala rivers, the tributary of the latter, and in the Kurkur-Su River in the Talass Ala-Tau.

Thus, Central Asia has a number of points with radioactive elements of the thorium group which are of interest to the research workers and in some cases to the industrialist. As we have shown, however, all occurrences of radioactivity here are greatly varied and need special procedures for industrial utilization. Nature, although generous, has presented these manifestations in forms which hamper their utilization.

What has been said indicates the main direction along which the work of mastering these recently discovered radioactive substances in Central Asia should proceed. First of all, we must consider the necessity of extensive prospecting work, the nature and future tasks of which have been clearly outlined by existing data. For the Tyuya-Muyun deposit, prospecting work should first of all attempt to determine the genesis and morphology of the ore body. The first step in this direction is to ascertain in detail the tectonics and hydrology of the deposit, which, on the basis of known facts, will coincide with the task of draining water from the advance workings and will renew the possibility of continuing the exploitation and prospecting operations along the main lode of the mine below the ground-water level. At the same time, the work begun in 1932 of drill prospecting from the mine's lower levels of the fields located in the sphere of the ground water should be continued. There is still the possibility that, by using comparatively shallow drill holes arranged in a sufficiently dense pattern, the ore materials of the depths can be determined and the degree of their preservation under the action of water and the nature of their stratification and formation can be explained.

In Taboshar, prospecting work should first of all sum up the work done in preceding years, and should, in particular, relate the tremendous amount of radiometric data obtained by A. P. Kirikov and associates to the physical or substantial evidence. The present radiometric network of curves has only provisory significance, and their physical significance and their conformity, or the degree of conformity, to reality is far from clear. At the same time, such work is most interesting, particularly from the point of view of the study of the distribution of radioactive substances in the earth's crust and the study of the role of radioactive phenomena in nature, a role which, according to present data, is extremely great, but which has still been given relatively little detailed and systematic study.

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Scientific study of natural phenomena has led mankind to the organization of meteorological, hydrological, and seismological services, etc., which make large-scale and systematic observations of nature and which provide a tremendous accumulation of factual material, enabling in many cases a completely accurate breakdown and systematization into corresponding fields. Just as timely and necessary is the organization of a radiometric service of this type which would provide systematic observations and studies of the scheme of radioactivity in the earth's crust. The radiometric survey work done in Taboshar is of interest primarily as a somewhat extensive experiment in the direction of developing the appropriate methods for this work. Of similar interest would be the transference of the experience of Taboshar to the Tyuya-Muyun Mine. It is possible that the use here of the emanation survey, as done in Taboshar, might make it possible to analyze the interrelation of the numerous and varied tectonic manifestations which, indisputably, have had enormous significance in the formation of the ore body and ore field of Tyuya-Muyun. All these tectonic fissures, the slip planes, and the relative shift of the rock masses may be the routes by which the air enriched by radioactive emanation diffuses into the fields directly connected with the surface. And the corresponding work in determining the concentration of the emanations in the soil and in the alluvium of the mine and also in the underground workings may assist somehow in placing these routes on the map and in explaining the principle of their distribution, which is still far from being sufficiently determined.

There is also the possibility that this work, coordinated with the actual and careful study of the manifestations of tectonic processes, will assist in disclosing and in locating those deeply hidden accumulations of rich radioactive materials which are still a subject of speculation and the existence of which is supposed on the basis of certain occasional, not fully dependable, signs and observations. On the basis of this radiometric survey of Taboshar, and along with any further work, it will be necessary to examine the occurrence of relatively richer accumulations of ore material for the purpose of extracting them by more inexpensive methods for industrial processing. Above we have defined the minimum percent of the content of uranoso oxide-uranic oxide which an ore material may have in order for it to be processed for radium salts. But we do not know how this material is distributed on the surface zone of the deposit, how much of it there is, nor how much it would cost to remove it from the deposit. Without an answer to these questions, it is impossible to begin exploitation of the deposit on any extensive scale.

At the same time, the study of the nature of the underground zone of this deposit should be continued. This report is related to the study of its genesis and its further prospects in relation to the findings of accumulations of original mineral formations of uranium.

The nature of the prospecting and geological research work in studying the radium-bearing properties of petroleum-well waters has already been sufficiently outlined by us in describing this type of occurrence of radium in nature. Here obviously, should be posed the question of setting up a temporary radiological laboratory (stantsionar) in the areas of petroleum prospecting and extracting operations in order to provide complete, detailed, and systematic observations of the changes in the scheme of the radium-bearing property and mineralization of the water. These observations should be made, if only for several specially selected wells of the region, and all local springs and water sources should be recorded in relation to their radium-bearing quality.

Prospecting for radioactive minerals should also be conducted in other regions of Central Asia. It would be very effective to supply all geological prospecting parties in Central Asia with instruments, even the most elementary, for making observations in this field. If it is considered important at present

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to draw up a general radiological map of the USSR, then Central Asia, because of the above-stated reasons, can lay claim to the first advance in the development of such a map. One of the main tools in this work should be the radiometric survey.

A certain error was permitted in making the radiometric survey in the Taboshar, or more accurately, the Sarymsakly deposit. This error lay in the fact that the evidence of the radiometric survey was not checked by data and evidence of other, usual methods of prospecting deposits. Or perhaps this check was done at too far a distance -- to such an extent that, for example, it appears to be purely accidental that the radioactivity of the rock in one of the crosscuts increased as this crosscut was advanced up to the maximum radioactive evidences, determined by emanations on the surface. Some geologists, therefore, consider all this work as somewhat unconvincing and even superfluous. But such is not the case. In prospecting and studying the manifestations of radioactivity in nature, extensive use should be made of the radiometric method based on the utilization of specific veins of radioactive substances. The use of this method, as a new and yet untested tool, should be done with utmost scientific care and strict verification. It also should be taken into account that, in the detailed study of such scattered and freakish accumulations of radioactive substances as are found in the Taboshar section or in the Zeravshan Valley, radiometry may actually be the only means of rapid and relatively inexpensive location of deposits. It seems, therefore, in light of all that has been said, that the use of the radiometric method in studying the wide zone of radioactive manifestations in the southern part of the Fergana Valley and in the valley of the Zeravshan River is entirely necessary, as are field tests for making this method more accurate.

Work on industrial utilization of the radium-bearing waters of which we have dealt at length above is being advanced unconditionally. The work has already begun, and it should proceed in those directions which have been indicated above.

Further, it is important to complete the work on the industrial utilization of the Taboshar deposit. In this connection the author has already done some laboratory work in this direction. Pilot-plant tests should be made for this purpose, relating this work to those measures which have been carried out in the mine itself and which can be termed, in a way, industrial prospecting. It would be more appropriate to conduct the pilot-plant tests in the deposit itself, first going to some additional expense in detailing scientific workers and in transporting necessary equipment and materials.

For Tyuya-Muyun, it is necessary to start organizing the work of concentrating the tailings or intermediate products obtained by concentrating the ore by hand. Moreover, it is essential, for the purpose of increasing the supplies of radioactive elements in our institutes and research institutions, to work on the problem of recovering from the ore other radioactive elements, of which protactinium is the most important. In addition to its practical interest, this work can have tremendous scientific significance. The laboratories of "Giredmet" have already started this work this year. It must be completed as soon as possible.

Finally, we must consider one more step in utilizing the radium-bearing resources of Central Asia and that is the construction of health resorts at deposits of radioactive minerals. In this case we can refer to foreign practice. The oldest enterprise for production of radium salts is Joachimsthal in Czechoslovakia. This enterprise is closely connected with the local health resort which profits by the very location of the mine, its mountainous landscape, climate, the radioactivity of the spring connected with the deposit (activity 600 Ye. M. /EMU/), and even the plant tailings needed for radioactive

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mud. Even the exterior structure of the production buildings in this enterprise is adapted to health-resort requirements, and at first glance it is difficult to tell where the factory and production process leave off and the health resort begins. The combination of the production process with the resort in all probability played an important part in the success of the enterprise during the sharp competition with Belgian radium enterprises, when US radium plants closed down.

The Tyuya-Muyun and Taboshar deposits are also very attractive for health-resort purposes from the point of view of climate and picturesque landscape. The presence of radioactive materials enables them definitely to be used along the lines of radiotherapy. The mine waters of the Taboshar Mine posses activity exceeding the activity of the waters of Joachimsthal. The development of health resorts in these locations, or at least in one of them, can have tremendous significance in other respects as well.

Both of these deposits are extremely far from cultural centers and have no evidences of cultural activity within their regions. This is naturally an obstacle in the attraction to these locations of skilled workers, who are absolutely necessary to the solution of the complex and extremely interesting problems connected with these deposits. These problems and the deposits are not being given the proper attention because of this. Any expedition proceeding there from the Center is evidence of the interest, but the departure of the expedition takes with it the impulses for further expansion of the work. The areas are left once more to themselves to continue in the same condition as they were in prior to the last expedition or commission. It occurs to no one to advance those plans and projects drawn up by these commissions.

The establishment of health resorts would help to eliminate these conditions and would positively transform these interesting areas, through somewhat provincial, into more cultured regions. Moreover, the health resorts would tend to interest the local population in the operation of these deposits and acquaint them with the work being done. From this point, there would be established a closer relationship between the enterprises and local agencies, eliminating the latter's isolationism and indifference to the deposits.

This problem is worth discussion, therefore, not only because of the desirability of creating in Central Asia the only radioactive health resorts in the USSR, but also because of the desirability of ensuring future prosperity and the successful development of this matter as a whole. These deposits are such that they are capable not only of supporting large-scale, though not fully utilized, enterprises on the base of their own natural resources which remain in a specifically concealed form, but also have many secondary advantages which we must develop and utilize to the fullest extent. And the construction of health resorts would be one of the first steps in this direction. The problem of utilizing the Central Asian radioactive deposits to their fullest extent should be advanced even at this very moment. The health resort should be of concern not only to the corresponding division of the local health department, but also to the economist and producer.

We must also work to overcome the lack of easy communication with the Center and the cultural deficiencies in the regions of these Central Asian ore deposits. All measures should be taken to further an extensive rise in the cultural and material life in Central Asia.

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/Appended figures follow/

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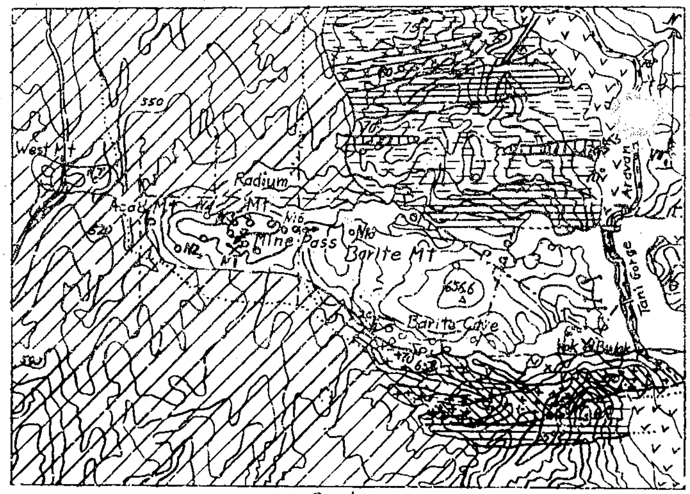
Figure 1. Schematic geological map of Tyuya-Muyun region drawn in 1924 by D. I. Shcherbakov, a geologist at the mine, and Prospecting Engineer A. P. Kirikov. Numbers at the lode formations identify them in the mine operations. No 1 indicates the main lode, described in the text.



Scale
250 0 250 500 750M

Contour level 21 m

- River deposits, talus
- Late Eocene conglomerates
- Marble-like limestone of lower carboniferous age
- Diabase
- Diabase and keratophyric tuff and volcanic breccia
- Siliceous shales
- Anthraconite
- Sandstone
- Carbonaceous shales
- Quartz porphyry and keratophyre
- Extinct hot springs
- Active hot springs
- Barite and ore lodes
- Dislocation fissure, faults
- Strike and dip of cleavage planes

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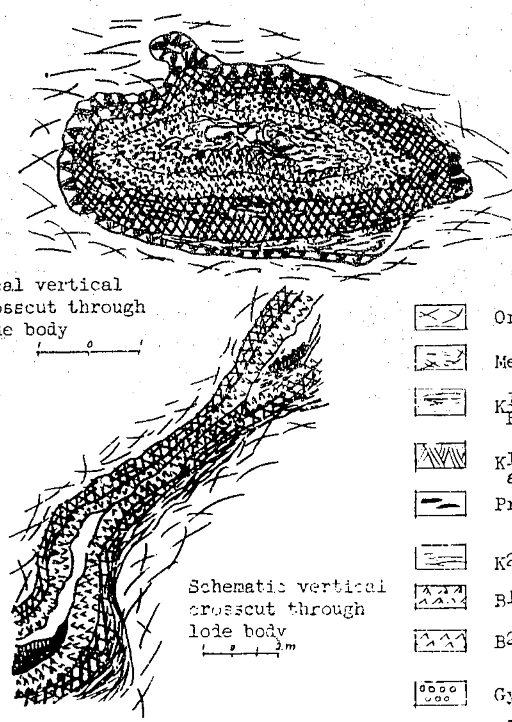
Ideal vertical crosscut through lode body



Schematic vertical crosscut through lode body

Original limestone

Metamorphic limestone

K^1_F Karstic stalagmitic crust

K^1_a Columnar stalactite

Primary uranium vanadate

K^2 Ore marble

B^1 Red barite

B^2 and B^3 Amber and transparent barite

Gypsum

K^1_B Stalagmitic crust and terra rossa of most recent karst

K^3_a Calcite crust of recent Karst, K^3_b marble onyx with incrustations

Cavities of the holes

Figure 2

- E N D -

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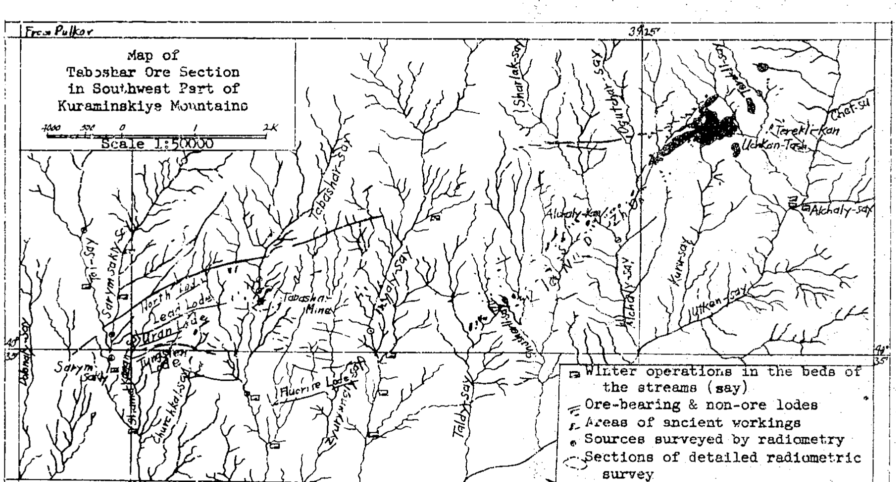

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